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The Patterns of Plant Community Distribution in the South-East Altai

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Abstract

The South-East Altai is the northern outpost of arid regions of Central Asia. It encompasses the Chuya depression (1800–2100 m), surrounding mountain ranges (2800–4000 m), mountain plateaus (2900–3200 m) and highland depressions (2200–2400 m). Eight types of altitudinal plant communities create the base of the plant cover pattern; each has its own specific set of active species. The altitudinal belt series is shown to include two belts: the steppe (1800–2400 m) and alpine belts (2400–2800 m). The belts are composed of lower and upper subbelts. The upper steppe subbelt has two variants, corresponding to relief peculiarities; two variants of the lower alpine subbelt are limited geographically.

Keywords: species activity, altitudinal belt series, steppe belt, alpine belt, Southeast Altai

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1. Introduction

The South-East Altai is the northern outpost of Central Asian arid area; the main part of Altai belongs to the boreal zone. The South-East Altai encompasses the Chuya depression (1800–2100 m), surrounding mountain ranges, mountain plateaus and highland depressions. The largest Altaian depression – the Chuya depression (1800–2100 m) – reaches 70 km in length and 30 km in width (Figure 1). At the bottom, one finds the River Chuya (the basin of the River Ob). The steep flanks of mountain ranges encircle the depression: the Kurai ridge (2800–3800 m) forms its northern border, the spurs of the North Chuysky range (2500–3000 m) – the western, the South Chuyskyi ridge (3400–3900 m) – the southwestern and the Chikhacheva ridge (3000–4000 m) – the eastern. The heights of the Ukok and the Sangilen plateaus, forming the southern part of the South-East Altai, gradually increase from the edges (2200–2400 m) to the center (2900–3200 m). The Tarkhata depression (2200–2400 m) is situated to the south of the

Chuya depression, while the Dgulukul' depression (2200–2400 m) is to the northeast [1].

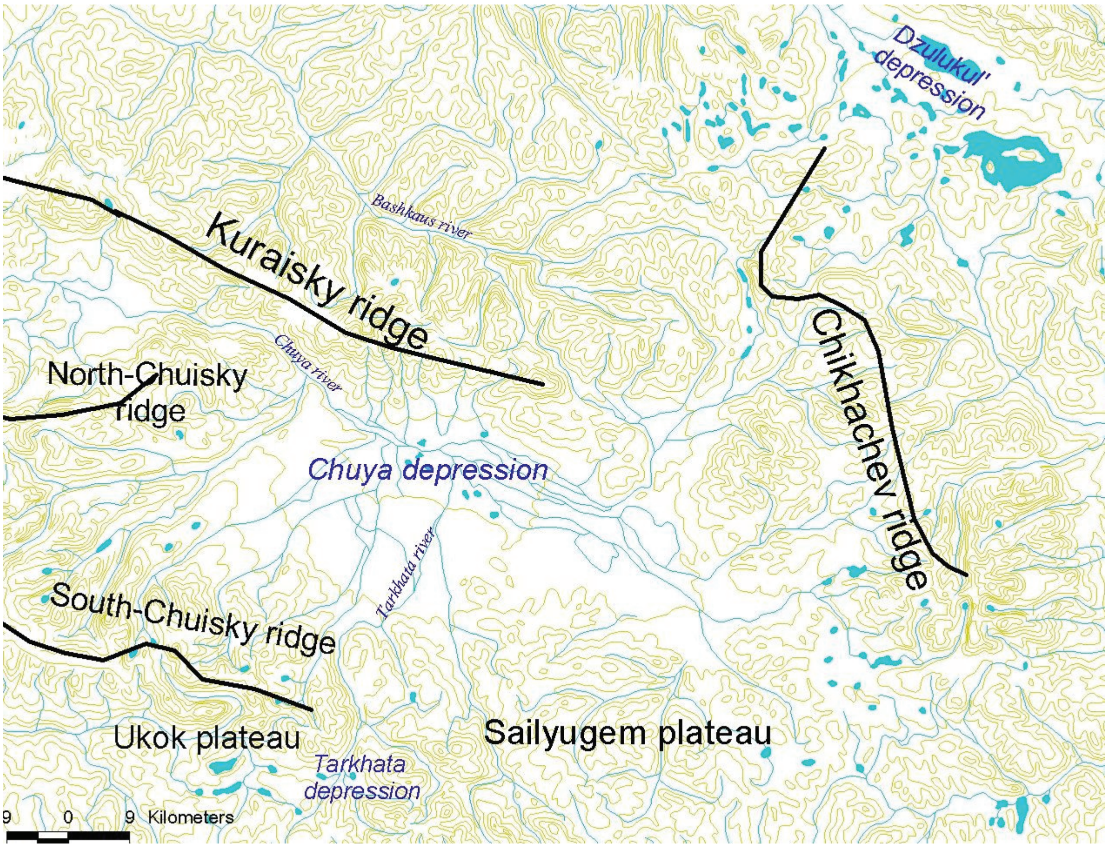

Figure 1: The South-East Altai. Source: Author's own work.

The rivers of the South-East Altai originate in ridges or plateaus and flow into the River Chuya. In the lower reaches, the valley slopes, formed by ancient glaciers, look like abrupt rocky slopes accompanied by stony screes. In the middle course, the river valleys also maintain traces of their glacial past: they bear numerous little glacial cirques at different stages of destruction. In the upper course, the valleys are limited by low banks.

The three main types of climate appear to correspond to three main geomorphological units: (1) the climate of the Chuya depression, (2) the climate of the flanks of the mountain ridges encircling the Chuya depression and (3) the climate of high-altitude ridges, plateaus and basins.

In fact, the Chuya depression is known as 'pole of cold' in the Altai: in January, the average temperature is –32°C. Low winter temperatures are caused by Siberian anticyclones; the cold air flows down from the slopes, fills the intermountain depressions and creates temperature inversions. Mountain slopes are noticeably warmer than at the bottom of the depression: the average January temperature is –16°C. The climatic conditions of mountain flat tops are similar to those in a free atmosphere [2]: the average January temperature at an altitude of 3000 m is −18°C. In the summer, the Chuya depression is the warmest place in the South-East Altai: the average temperature in July is + 14°C, while on the surrounding mountains slopes, it is +11°C. At an altitude of 2500 m, the average July temperature goes down to +8°C, and at an altitude of 3000 m – to + 4°C. As result, in the Chuya depression the maximal annual temperature amplitude is observed; it reaches 46°C. On the surrounding mountain slopes, the amplitude reduces to 27°C, and in the flat watersheds – to 22°C.

In addition, the Chuya depression has the lowest annual rainfall on Altai, from 100 to 150 mm. The surrounding mountain slopes receive up to 400 mm of precipitation; annual rainfall at the height of the snow line reaches 600 mm on the Chikhacheva ridge and 800–1000 mm on the South Chuyskiy ridge.

As long ago as 1960, A. V. Kuminova [3] noted the presence of steppe and alpine altitudinal zones and the lack of a forest one in the South-East Altai; data from further investigations confirmed this thesis and specified some details, but their descriptions of vegetation were inconsistent with each other. This reasons for this ambiguity seem to be clear. First, there are several variants of altitudinal zoning throughout the South-East Altai. Second, there is no unified terminology for the delineation of arid mountain vegetation. The more correct approach is to process all available information on vegetation using a unified terminology. One way to realize this idea is:

1. to reveal the basic altitudinal types of plant communities of the South-East Altai;

2. to characterize their altitudinal belt spectrum peculiarities;

3. to find out the tendencies of altitudinal distribution of plant communities;

4. to define the altitudinal zone limits in the South-East Altai.

2. Methods

Altitudinal zone limits are known to be determined by altitudinal changes in zonal plant communities, confined to 'oroplacors' – gentle slopes and medium steep ones. To reveal zonal plant communities, we brought together 350 published geobotanical releves of oroplacors of the South-East Altai [3–10] and 310 unpublished releves of the author. The data was analyzed via the programs MEGATAB [11] and TWINSPAN [12].

To characterize each plant community type, we have focused on the following altitudinal zone groups: alpine species, mountainous species, forest-steppe (meadow-steppe) species, steppe species and desert-steppe species. We have considered separately cryoxerophytic and petrophytic species; the first unites the species of the highland steppes, while the second includes species of the mountainous petrophytic steppes.

The activity of the species has been calculated as the square root of the multiplication of constancy by mean cover [11]. Only active (activity $\geq$ 20) and moderately active (20 > activity $\geq$ 10) species have been included. Active species dominate in plant communities, while moderately active species are codominants.

3. Results

The diversity of zonal plant communities was found out to be composed of 8 types:

(i) desert steppe;

(ii) typical bunch-grass steppe;

(iii) petrophytic bunch-grass steppe;

(iv) cryophytic steppe;

(v) cryophytic larch forest;

(vi) shrubby tundra with *Betula rotundifolia*;

(vii) tundra-steppe;

(viii) Kobresia tundra.

Each type of zonal plant community has a specific spectrum of active species (Figure 2). Typically, the zonal community type should be dominated by its zonal altitudinal group. Indeed, the spectrum of the active species of desert steppe (i) consists of steppe and desert-steppe species; in the spectrum of typical bunch-grass steppe (ii), steppe species form the main part. Alpine species predominate the spectra of shrubby (vi) and Kobresia (8) tundra (60% and 70%, respectively); the rest in shrubby tundra is formed by forest and mountainous species, while in Kobresia tundra it is constituted by mountainous and meadow-steppe species. However, in cryophytic larch forests (v) forest species make up only half: the rest includes alpine and meadow-steppe species. Petrophytic bunchgrass steppe (iii), cryophytic steppe (iv) and tundra-steppe

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(vii) have more complex spectra of active species. The spectrum of petrophytic bunch-grass steppe (iii) comprises 4 components: steppe species prevail (70%), while the rest is made up of petrophytic steppe (17%), meadow-steppe (7%), and cryophytic (6%) species. The cryophytic steppe spectrum (4) includes 5 components: meadow steppe (33%), steppe (31%), alpine (12%), mountainous (12%), and cryophytic steppe (12%) species. Alpine, mountainous, meadow-steppe, cryophitic steppe, and steppe species have a similar percentage in the tundra-steppe spectrum (vii).

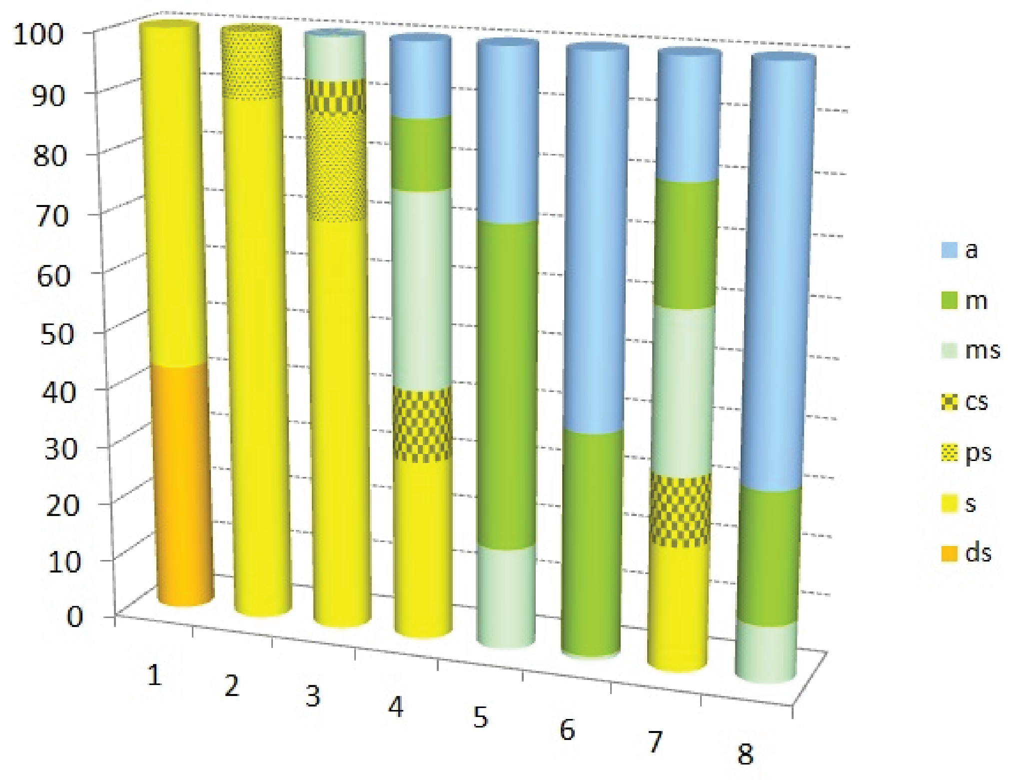

Figure 2: The spectra of active species of zonal types of plant communities. Legend: a – alpine species; m – mountainous and forest species; ms – meadow-steppe species; cs – cryoxerophytic species; ps – petrophytic species; s – steppe species; ds – desert steppe species. 1 – desert steppe; 2 – typical bunch-grass steppe; 3 – petrophytic bunch-grass steppe; 4 – cryophytic steppe; 5 – cryophytic larch forest; 6 – shrubby tundra; 7 – tundra-steppe; 8 – Kobresia tundra. Source: Author's own work.

The altitudinal zone series in the South-East Altai is known to comprise of two belts (altitudinal zones): steppe (1800–2400 m) and alpine (2400–2800 m). Each belt is made up of two subbelts: upper and lower. The limits of altitudinal zones correspond to the main relief forms.

The steppe belt (1800–2400 m) is confined to the Chuya depression and the adjacent flanks of mountain ranges. The lower subbelt (1800–2100m) occupies the plain spaces of bottom of the Chuya depression. The background plant communities are typical of the bunch-grass steppe (ii) and desert steppe (i); the pattern of their distribution is determined by topography. Desert steppes (i) cover more arid, fine-graveled spaces, while typical bunch-grass steppes (ii) are areas with more developed soils. The upper part of the steppe belt (2100–2400 m) is confined to the flanks of the mountain ranges facing to the Chuya depression. There are two main forms of relief here. The first form is characteristic of the mountain flanks of the Chuya depression. Steep rocky slopes and screes dominate; the background vegetation is petrophytic bunch-grass steppe (iii) and separate groups of petrophytic plants. The second form of relief occurs in middle-course river valleys, which are filled with the numerous remnants of cirques. The background plant communities are cryophytic larch forest (v) and cryophitic steppe (iv). In the arid conditions of the South-East Altai, forests can exist only due to the moisture received in the summer during the melting of the ice permafrost. Cryophytic larch forest (v) covers concave slopes, while cryophytic steppe (iv) covers convex ones.

The alpine belt ((2200) 2400–2800 m) dominates on mountain ridges, plateaus, and in high-mountain depressions. Two pattern of vegetation cover characterize the lower part of the alpine belt ((2200) 2400–2600 m). The first pattern is typical of the northern, western and central parts of the South-East Altai. The slopes of shadow exposures are covered with shrubby tundra (vi); the sunny slopes – with Kobresia tundra (viii) and tundra-steppe (vii). Tundra-steppe is confined to the stony part of the slopes; Kobresia tundra occupies areas with more developed soils. On the mountain flanks facing the Chuya depression, stony areas dominate; so the background vegetation here is tundra-steppe. The inner highlands have smoothed relief without a large stony space, and their vegetation cover is a regular alternation of shrubby (vi) and Kobresia (viii) tundra.

The second pattern is characteristic of the southeastern part of the South-East Altai. The background vegetation is tundra-steppe (vii); on convex, gravelly substrates, cryophytic steppe (4) is present. In the vegetation cover of the upper part of the alpine belt (2600–2800 m), Kobresia tundra absolutely dominates.

4. Conclusion

(i) The diversity of zonal plant communities of the South-East Altai is represented by 8 types; each has a specific set of active species.

(ii) The altitudinal zone series in the South-East Altai is comprised of two belts (altitudinal zones): steppe (1800–2400 m) and alpine (2400–2800 m). Each belt is made up of two subbelts.

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